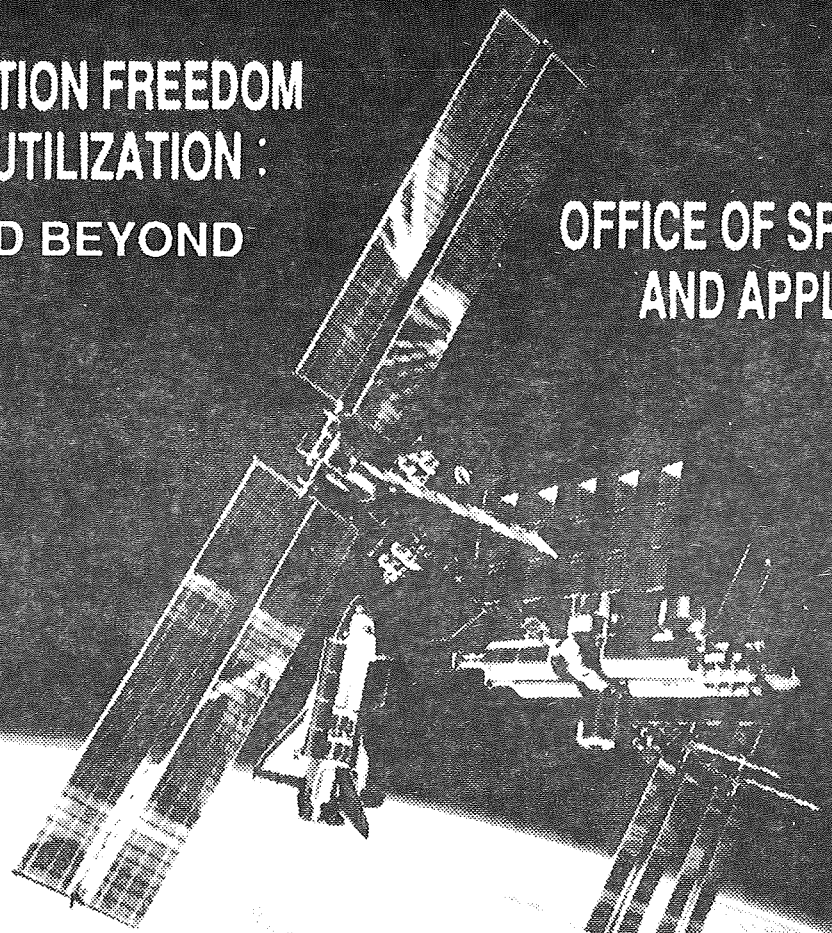
SPACE STATION FREEDOM SCIENCE UTILIZATION : 2000 AND BEYOND

OFFICE OF SPACE SCIENCE AND APPLICATIONS



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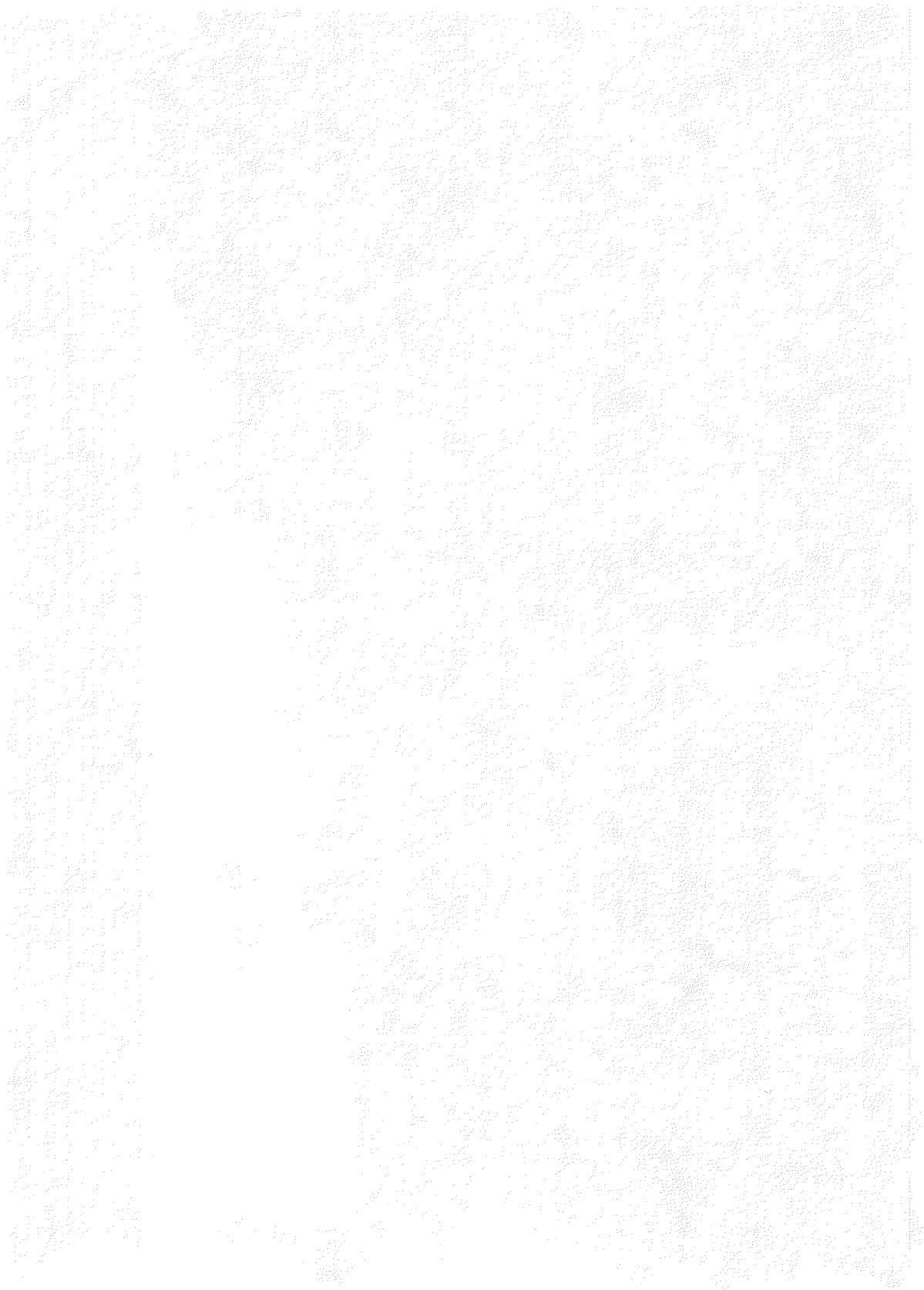
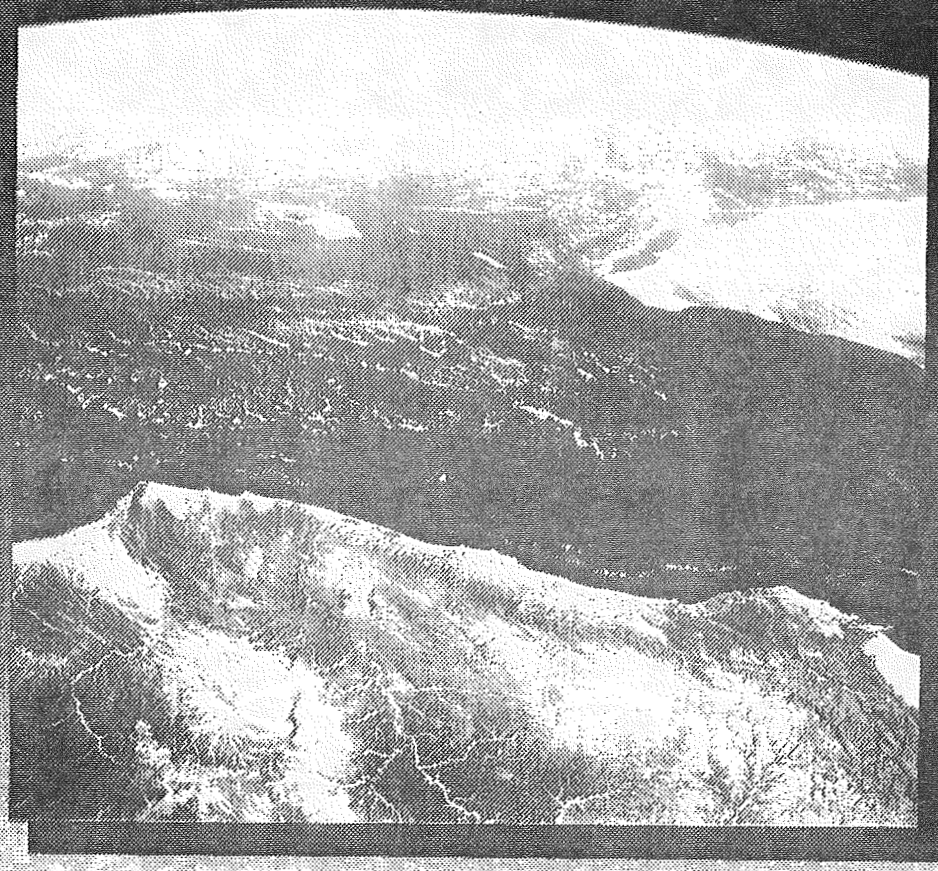


OFFICE OF SPACE SCIENCE AND APPLICATIONS GOALS

TO ADVANCE SCIENTIFIC KNOWLEDGE OF THE PLANET EARTH, THE SOLAR SYSTEM, AND THE UNIVERSE.

TO UNDERSTAND THE EFFECTS OF THE SPACE ENVIRONMENT ON BIOLOGICAL AND PHYSICAL PROCESSES.

TO EXPAND THE HUMAN PRESENCE BEYOND THE EARTH INTO THE SOLAR SYSTEM.



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STRATEGIC PLAN

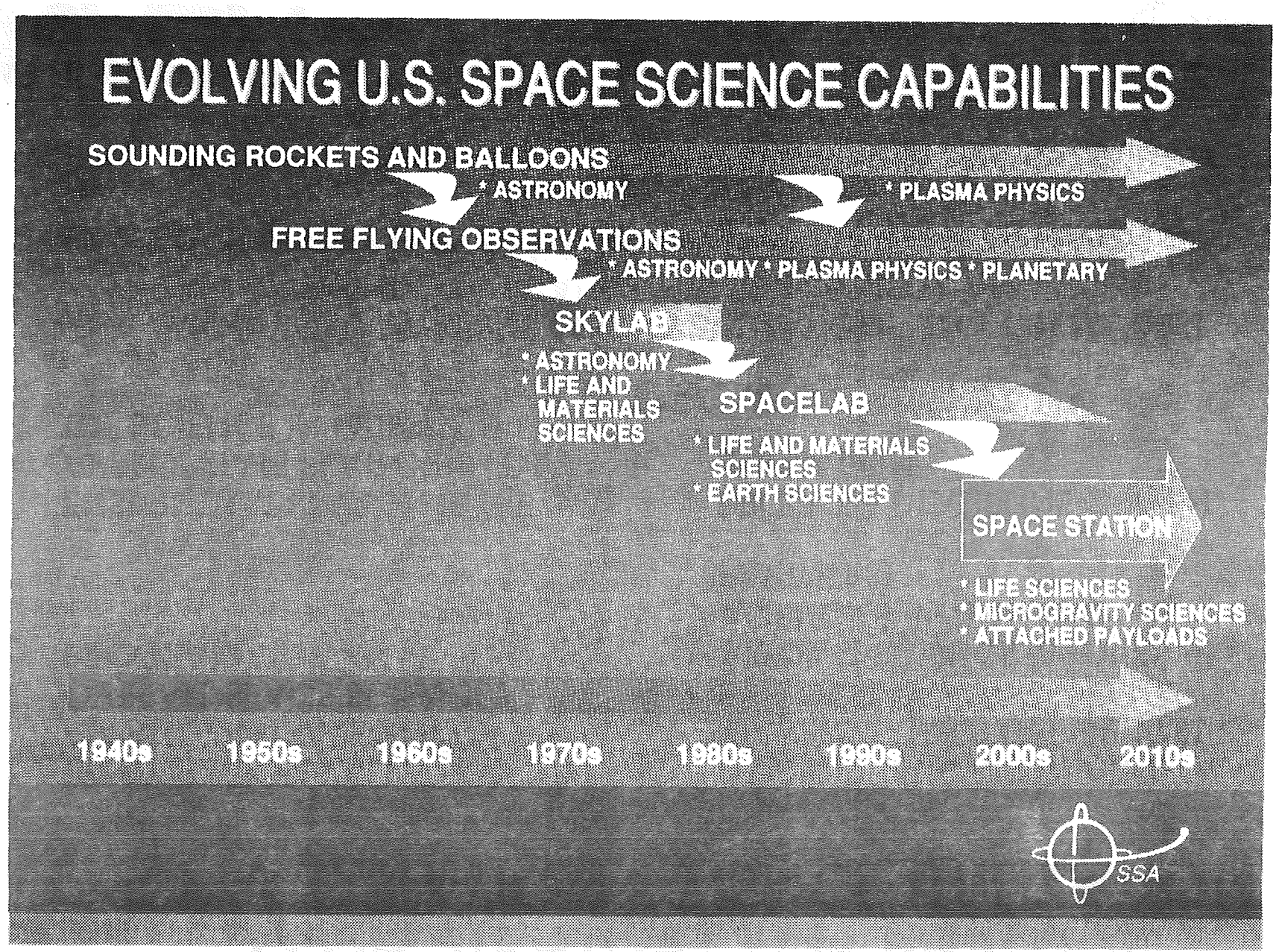
COMPLETE THE ONGOING PROGRAM

INITIATE A MAJOR OR MODERATE MISSION EACH YEAR

INITIATE SMALL MISSIONS FOR INCREASED OPPORTUNITIES

TRANSITION TO SPACE STATION FREEDOM

MAINTAIN AND AUGMENT THE RESEARCH BASE



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OSSA STRATEGY FOR BASELINE SPACE STATION SCIENCE UTILIZATION

TREAT STATION UTILIZATION AS AN INTEGRAL ELEMENT OF THE OVERALL SPACE SCIENCES PROGRAM

AVOID DUPLICATION AND MAXIMIZE USER OPPORTUNITIES BY COORDINATING PLANS AMONG SCIENCE GROUPS (U.S. AGENCIES, INTERNATIONAL PARTNERS)

ENSURE THAT STATION IS THE APPROPRIATE PLATFORM FOR THE SCIENCE IN QUESTION

PROMOTE DISCIPLINE-DRIVEN UTILIZATION

→ EVOLUTIONARY APPROACH TO UTILIZATION: RELY ON MODEST EXPERIMENTATION INITIALLY, INTRODUCE MORE AMBITIOUS EXPERIMENTATION AS WE "LEARN HOW TO USE THE STATION"

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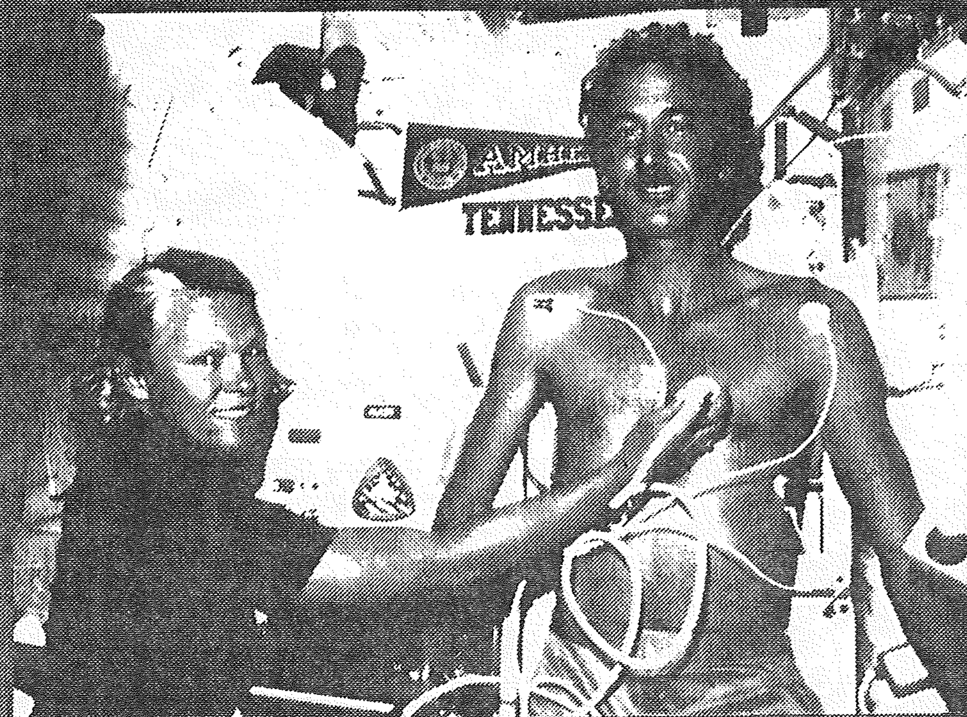
LIFE SCIENCES GOALS

TO DEVELOP MEDICAL AND BIOLOGICAL SYSTEMS THAT ENABLE THE HUMAN EXPLORATION AND HABITATION OF SPACE.

TO UNDERSTAND THE ORIGIN, EVOLUTION, AND DISTRIBUTION OF LIFE IN THE UNIVERSE.

TO UNDERSTAND THE RELATIONSHIP BETWEEN LIFE AND GRAVITY AND OTHER PLANETARY PROPERTIES.



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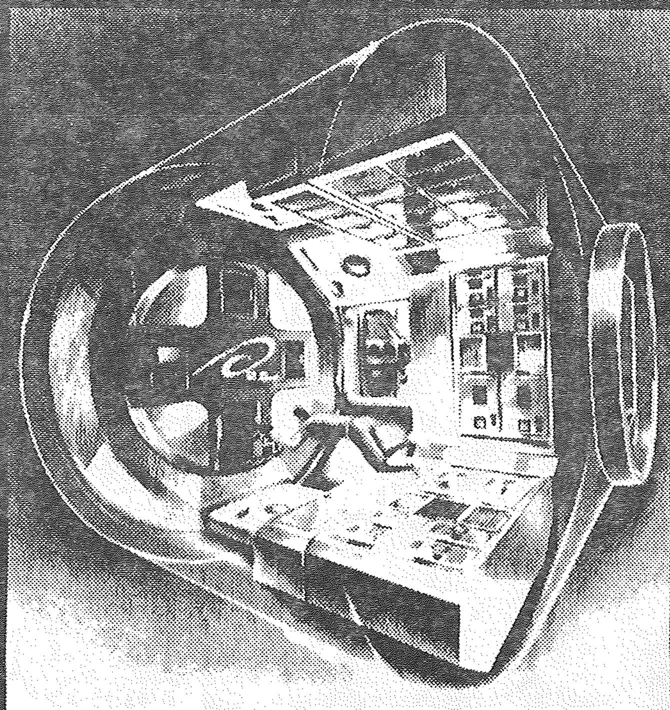
LIFE SCIENCES FACILITIES



CENTRIFUGE FACILITY

- CENTRIFUGE
- GRAVITATIONAL BIOLOGY
- SPACE PHYSIOLOGY
- GAS-GRAIN SIMULATION
- CLOSED ECOLOGICAL LIFE SUPPORT SYSTEM TEST FACILITY

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OSSA SPACE STATION PAYLOAD TRAFFIC MODEL MAY 1991

Life Sciences Pressurized Volume Payloads

Calendar Year →	1996	1997	1998	1999	2000	2001	2002	2003
CENTRIFUGE FACILITY Centrifuge (CF) Habitat Holding Facility				2.5 m CF		UNDER REVIEW		
Gravitational Biology Facility								
EVA/Space Physiology Facility/BMAC	EVA			SP/BMAC				
Gas-Grain Simulation Facility								
CELSS Test Facility								
Rack Outfitting	2		4	6[2] + CF				
Cum. Racks On Station	2	2	6	10 + CF	10 + CF			

KEY

[ ] RACKS REMOVED

1 Space Station Double Rack

1 Space Station Double Rack - Removed

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LIFE SCIENCES: PRE-PMC

PHASE I: EVA/HUMAN PHYSIOLOGY

- COMMENCES WITH MTC

- RESEARCH FOCUSING ON THE PHYSIOLOGICAL RESPONSES TO REPEATED EVA, AND MONITORING OF HUMAN HEALTH AND ENVIRONMENT OF SSF. SPECIFIC AREAS OF RESEARCH WILL INCLUDE:
  - PULMONARY STUDIES
  - CARDIOVASCULAR RESEARCH
  - METABOLIC AND MUSCULOSKELETAL STUDIES
  - NEUROSCIENCE RESEARCH

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LIFE SCIENCES: PRE-PMC

PHASE II: LIFE SCIENCES/LIFE SUPPORT

- COMMENCE AROUND PMC

- BIOMEDICAL AND LIFE SUPPORT RESEARCH ACTIVITIES WILL BE INITIATED DURING THIS PHASE TO:

  - EXPAND UNDERSTANDING OF BASIC HUMAN PHYSIOLOGY IN WEIGHTLESSNESS

  - DEVELOP BIOREGENERATIVE LIFE SUPPORT SYSTEM TO SUPPORT CREW HEALTH MAINTENANCE

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LIFE SCIENCES: POST-PMC

PHASE III: MEETING EXPANDED SCIENCE AND OPERATIONAL REQUIREMENTS

CURRENT PLANNING CALLS FOR AN INTERNATIONAL LIFE SCIENCES RESEARCH FACILITY ON SSF TO SUPPORT CONTINUOUS SCIENTIFIC INVESTIGATIONS FOR MORE THAN 20 YEARS FOR:

- **RESEARCH DEVOTED TO INDEPTH STUDY IN MEDICAL AND BIOLOGICAL DISCIPLINES OVER PROLONGED PERIODS OF TIME**
- **ESTABLISHING A CAPABILITY TO ADDRESS MEDICAL ISSUES WHICH WILL ENABLE LONG DURATION HUMAN EXPLORATION MISSIONS**

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LIFE SCIENCES: POST-PMC

BY THE YEAR 2001, THE FOLLOWING CAPABILITIES WILL BE AVAILABLE TO BE USED FOR THE NEXT TWO DECADES ABOARD SSF:

- THE GRAVITATIONAL BIOLOGY FACILITY (CENTRIFUGE): CONTROLLED LEVELS OF ARTIFICIAL GRAVITY TO SEPARATE THE EFFECTS OF WEIGHTLESSNESS FROM OTHER ENVIRONMENTAL FACTORS

- THE CELSS TEST FACILITY: CONTROL, MONITOR, AND EVALUATE THE GROWTH OF CROP PLANTS AS A MEANS OF STUDYING BIOREGENERATIVE SUBSYSTEMS

- GAS-GRAIN SIMULATION FACILITY: STUDY CHEMICAL AND PHYSICAL PROCESSES SUCH AS THE FORMATION, GROWTH, ACCRETION, AND INTERACTION OF CLOUDS, DUST GRAINS, AND OTHER PARTICLES IN MICROGRAVITY

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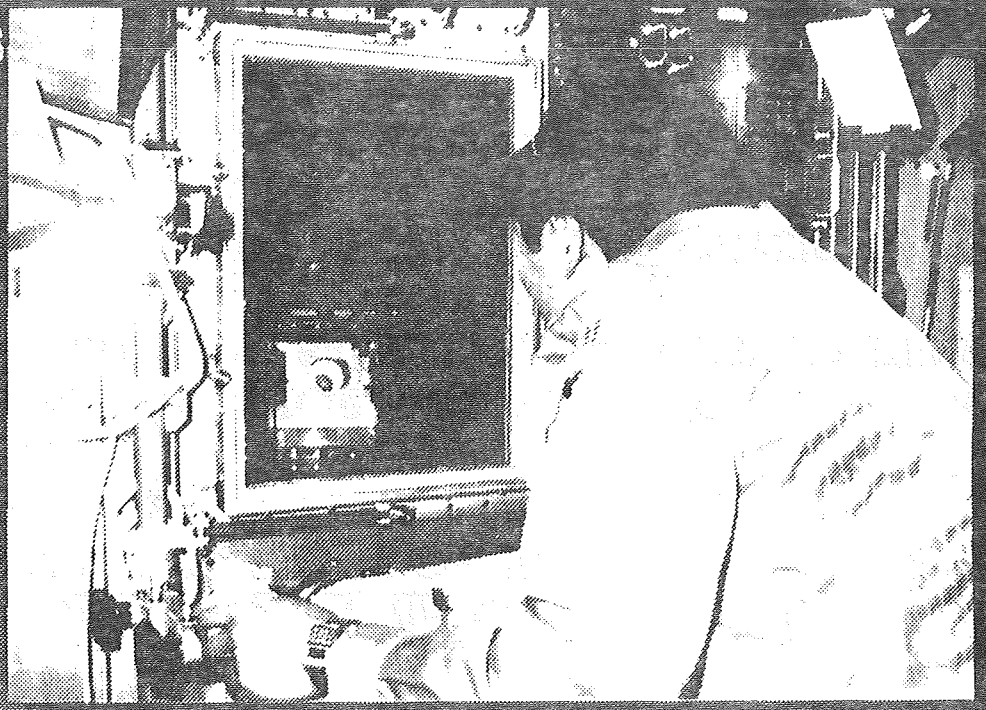
MICROGRAVITY SCIENCE AND APPLICATIONS GOALS

TO INVESTIGATE THE BEHAVIOR OF MATERIALS AND FLUIDS AND THE EFFECTS ON PROCESSES CARRIED OUT IN THE MICROGRAVITY ENVIRONMENT,

TO PROVIDE A BETTER UNDERSTANDING OF THE EFFECTS AND LIMITATIONS IMPOSED BY GRAVITY ON PROCESSES CARRIED OUT ON EARTH,

TO EVOLVE PROCESSES THAT EXPLOIT THE UNIQUE CHARACTERISTICS OF THE MICROGRAVITY ENVIRONMENT OF SPACE TO ACCOMPLISH RESULTS THAT CANNOT BE OBTAINED ON EARTH, AND

TO EXPLORE AND DETERMINE POTENTIAL APPLICATIONS FOR COMMERCIALIZATION IN SPACE.



MICROGRAVITY SCIENCE AND APPLICATIONS FACILITIES SUPPORTING FUNDAMENTAL SCIENCE, MATERIALS SCIENCE & BIOTECHNOLOGY

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OSSA SPACE STATION PAYLOAD TRAFFIC MODEL MAY 1991

Microgravity Science and Applications Pressurized Volume Payloads

Calendar Year →	1996	1997	1998	1999	2000	2001	2002
Spacelab Transition Payloads	5	1	[4]	[2]			
Advanced Protein Crystal Growth Facility						UNDER REVIEW	
Space Station Furnace Facility							
Modular Containerless Processing Facility							
Combustion/Fluids Facility							
Fundamental Science and Small Rapid Response				On Free-Flyer			
Biotechnology Facility		UNDER REVIEW					
Total Transport		1	4	4 [1] + 1FF	3 [2]		
Cumulative Racks On Station		1	5	8 + 1FF	9 + 1FF		

KEY [ ] RACKS REMOVED

1 Space Station Double Rack

1 Space Station Double Rack - Removed

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MICROGRAVITY SCIENCE & APPLICATIONS: PRE-PMC

PHASE I: MAN-TENDED/TRANSITION HARDWARE

- COMMENCES WITH MTC TO MID-1998
- EMPHASIS ON USING HARDWARE ORIGINALLY DESIGNED FOR SHUTTLE BUT ADAPTED TO SSF
- EXPERIMENTS IN MATERIALS SCIENCE, FLUID PHYSICS AND DYNAMICS RESEARCH, AND PROTEIN CRYSTAL GROWTH EXPERIMENTS

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MICROGRAVITY SCIENCE & APPLICATIONS: PRE-PMC

PHASE II: MAN-TENDED/FACILITY-CLASS HARDWARE

- 1998-99 TO PMC
- RESEARCH TO CONTINUE IN MATERIALS SCIENCE, FLUIDS, AND PROTEIN CRYSTAL GROWTH DISCIPLINES, BUT WILL ADDRESS MORE MATURE SETS OF QUESTIONS
- COMBUSTION SCIENCE TO BE STUDIED (PREREQUISITE FOR OUTER PLANET EXPLORATION)

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MICROGRAVITY SCIENCE & APPLICATIONS: POST-PMC

PHASE III: PERMANENT MANNED PRESENCE

- PMC ONWARD
- ALLOWS ITERATIVE SETS OF ON-ORBIT EXPERIMENTS REQUIRING EXTENDED PERIODS OF MANNED INTERACTION AND INTERPRETATION

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MICROGRAVITY SCIENCE & APPLICATIONS: POST-PMC

PHASE IV: MAN-TENDED FREE FLYER

- BASED ON RESULTS FROM PREVIOUS PHASES, CERTAIN CLASSES OF EXPERIMENTS REQUIRING LONG EXPERIMENTS TIMES AND LOWER-GRAVITY LEVELS WILL MIGRATE TO FREE FLYER
- EXPERIMENTS WILL INCLUDE GROWTH OF TECHNOLOGICALLY IMPORTANT ELECTRONIC AND OPTO-ELECTRONIC MATERIALS

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MICROGRAVITY SCIENCE & APPLICATIONS: POST-PMC

BY THE YEAR 2001, THE FOLLOWING CAPABILITIES WILL BE AVAILABLE TO BE USED FOR THE NEXT TWO DECADES ABOARD SSF:

ADVANCED PROTEIN CRYSTAL GROWTH FACILITY: Evaluate the effects of gravity on the growth of protein crystals and study the physics/dynamics of crystal growth

SPACE STATION FURNACE FACILITY: Explore potential for using low gravity environment to develop unique materials or materials structures

MODULAR COMBUSTION FACILITY: Provide better understanding of fundamental theories of combustion processes; provide data for combustion-related applications such as spacecraft fire safety

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MICROGRAVITY SCIENCE & APPLICATIONS: POST-PMC

FLUID PHYSICS DYNAMICS FACILITY: Provide better understanding of fundamental theories of fluids processes; provide data for fluids-related applications

MODULAR CONTAINERLESS PROCESSING FACILITY: Conduct research on properties and phenomena that on Earth are seriously affected by container contamination

BIOTECHNOLOGY FACILITY: Culture tissue models for genetic regulations studies, and study function and differentiation in low mechanical stress environment

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FINAL OBSERVATIONS

- OSSA WILL TAKE AN EVOLUTIONARY APPROACH TO SCIENCE ONBOARD STATION
- MANY PRIOR AREAS OF CONCERN WITH STATION CAPABILITIES (I.E., POWER) HAVE IMPROVED; MORE ARE ON THE PATH TO RESOLUTION
- SCIENCE REQUIREMENTS AND PROGRAMS WILL TEND TO ADJUST TO REALISTIC STATION CAPABILITIES
- THERE ARE NO MAJOR OSSA INFRASTRUCTURE REQUIREMENTS FOR POST-PMC PERIOD

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